IECEx TEST REPORT COVER

ExTR Reference Number.....:	NO/DNV/ExTR09.0003/04
ExTR Free Reference Number .....:	PRJC-489530-2013-PRC-USA
Compiled by + signature (ExTL) ....:	Al Engler
Reviewed by + signature (ExTL)....:	Bjørn Spongsveen
Approved by + signature (ExCB)....:	Asle Kaastad
Date of issue .....:	2015-01-20
Ex Testing Laboratory (ExTL) .....:	Det Norsk Veritas Certification AS,
Address .....:	Veritasveien 1, 1322 Høvik, Norway
Ex Certification Body (ExCB) .....:	Det Norsk Veritas Certification AS,
Address .....:	Veritasveien 1, 1322 Høvik, Norway
Applicant's name.....:	Mistras Group Inc.
Address .....:	195 Clarksville Rd. PRINCETON JCT., NJ, 08550-5303 USA
Standards associated with this ExTR package.....:	IEC 60079-0:2011, 6th Edition, IEC 60079-11:2011 6th Edition

Clauses considered.....:	All clauses considered
Test procedure .....:	IECEx System
Test Report Form Number .....:	ExTR Cover_4 (released 2010-12)
Test item description .....:	This update adds four drawings to the document list that were omitted in the last revision.
Model/type reference.....:	

Barrier Interface	1281, 1281-LP	[Ex ia] IIC, [Ex ia] IIIC
Sensors with integrated amplifier	ISPK3I, ISPK6I ISPK15I, ISPK30I, ISPKWDI, ISPKF15I, ISPKF30I, ISPK50I, ISPKF50I, ISP3KI-6dB, ISPK6I-6dB, ISPK15I-6dB, ISPKF15I-6dB, ISPK30I-6dB, ISPKF30I-6dB, ISPK50I-6dB, ISPKF50I-6dB, ISPKWDI-6dB,	Ex ia IIC T6, -40°C≤Ta≤70°C Ex ia IIIC T85°C, -40°C≤Ta≤70°C
Sensors with integrated amplifier for use under water	ISPK3IUC, ISPK6IUC, ISPK15IUC, ISPK30IUC, ISPKWDIUC, ISPKF15IUC, ISPKF30IUC, ISPK50IUC, ISPKF50IUC, ISPK3IUC-6dB, ISPK61IUC-6dB, ISPK61IUC-6dB, ISPK15IUC-6dB, ISPKF15IUC-6dB, ISPK30IUC-6dB, ISPKF30IUC-6dB, ISPK50IUC-6dB, ISPKF50IUC-6dB, ISPKWDIUC-6dB	Ex ia IIC T6, -40°C≤Ta≤70°C Ex ia IIIC T85°C, -40°C≤Ta≤70°C
High temperature sensors for use with external pre-amplifier	ISR6CA-HT, ISR15CA-HT, ISR30CA-HT, ISWDCA-HT, ISR3CA-HT, ISRF15CA-HT, ISRF30CA-HT,	Ex ia IIC T4, -40°C≤Ta≤120°C Ex ia IIIC T135°C, -40°C≤Ta≤120°C Ex ia IIC T3,

		ISR50CA-HT, ISRF50CA-HT	-40°C≤Ta≤150°C Ex ia IIIC T200°C, -40°C≤Ta≤150°C
	External pre-amplifier	ISPK-3S, ISPK-6S, ISPK-15S, ISPK-30S, ISPK-WS, ISPK-3S-6dB, ISPK-6S-6dB, ISPK-15S-6dB, ISPK-30S-6dB, ISPK-WS-6dB	Ex ia IIC T6, -40°C≤Ta≤70°C Ex ia IIIC T85°C, -40°C≤Ta≤70°C

Code (e.g. Ex __ II__ T__).....:	See table above.
Rating .....:	Barrier interface: Um = 250V, Uo = 5,88V, Io = 0,297A , Po = 0,44W, Lo = 0,35mH, Co = 43□F
All testing fully performed by ExTL staff at ExTL address above:	Yes ~~/ No~~, See below for additional detail) Test results from previous versions of the certificate are included in the test section. No new testing was required.

Instructions for Intended Use of ExTR Cover:
An ExTR Cover is the sole top-level document to associate together all other parts of an IECEx Test Report (ExTR) package. An ExTR package is comprised of an ExTR Cover and one or more associated ExTR documents (which may include Ex Test Reports, ExTR Addendums and ExTR of National Differences). All ExTR package documents are compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the overall ExTR package on this ExTR Cover.

Manufacturer's name.....:	Mistras Group Inc.
Address .....:	195 Clarksville Rd. PRINCETON JCT., NJ, 08550-5303 USA
Trademark .....:	N/A

Particulars: Test item vs. Test requirements

Classification of installation and use ..... :	(~~portable /~~ stationary ~~/ hand-held~~)
Ingress protection .....:	IP20/IP67 on sensors
Rated ambient temperature range (°C).....:	See table above.
Rated service temperature range (°C) for Ex Components .....:	N/A

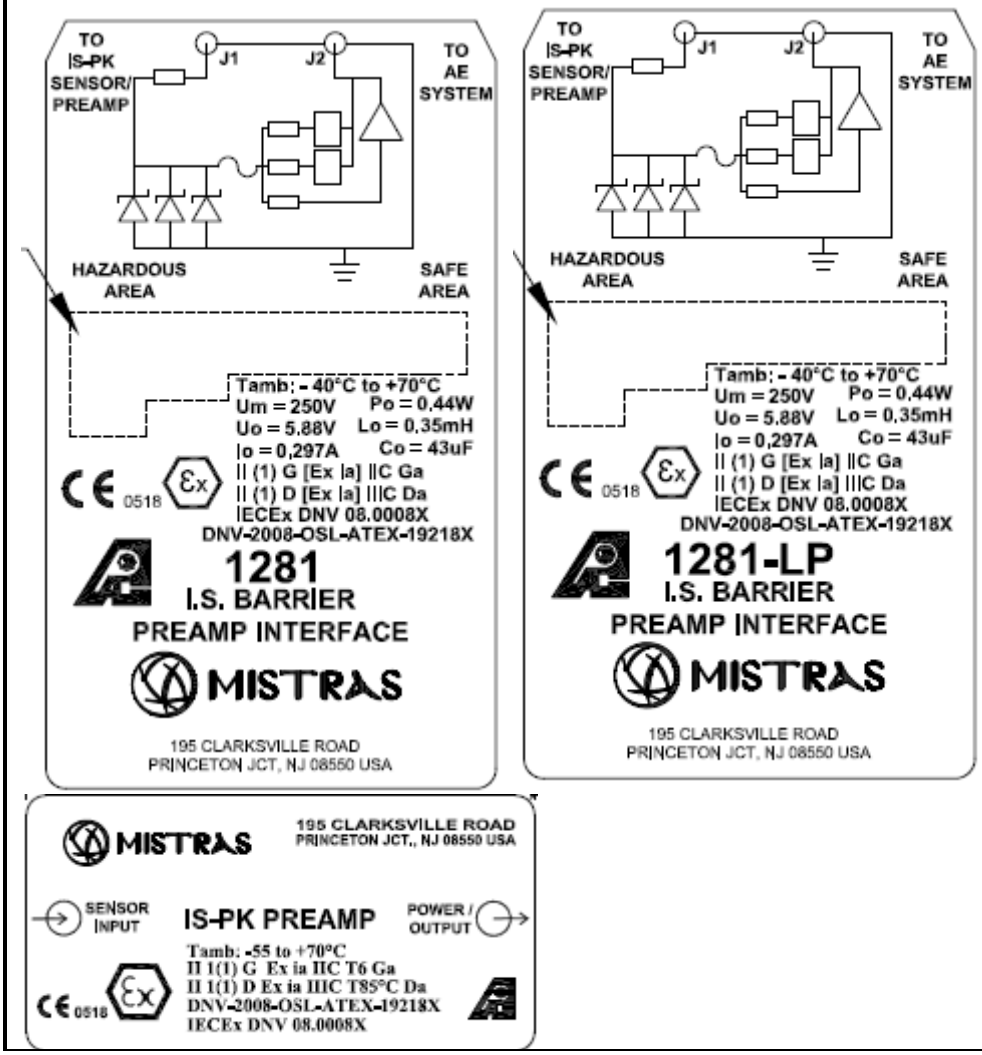
General remarks:

The test results presented in this ExTR package relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to the ExTR package.

- "(see appended table)" refers to a table appended to the ExTR package.
- Throughout this ExTR package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.*

Copy of Marking Plate:



Example of sensor marking

General product information:

The equipment consists of a series of ISPKxxI, ISPKxxUC and ISPKxxIUC sensors with a 1281 or 1281-LP barrier/preamp interface. The barrier interface supplies the sensors and pre-amps with an intrinsically safe signal. The Barrier/Preamp Interface also detects an AST signal from the standard AE system and sends it to the preamplifier/sensors where the sensors will generate tone bursts to send back to the AE system thru the barrier. The pre-amplifier can be integrated into the sensors or installed as a separate unit for high temperature applications.

In accordance with OD 024, testing not fully performed by ExTL staff at the above ExTL address:
None

National differences considered as part of this evaluation, if any:

None

"Conditions of Use" for Ex Equipment or "Schedule of Limitations" for Ex Components, if any:

The instructions indicates all the necessary information to ensure the installation minimizes the risk from electrostatic discharge.

Sensors with aluminium enclosures shall be installed as to protect them from ignition hazards due to impact.

Routine tests, if any: None

Manufacturer's Documents

Title:	Drawing No.:	Rev.	Date:
1281-2010	Layers Drawing, 1281 IS Barrier / Preamp Interface (5 pages)	1	2007-12-31
1281-2011	Drill/Fabrication Drawing, 1281 IS Barrier / Preamp Interface (2 pages)	1A	2008-05-01
1281-2014	Assembly Drawing, 1281 IS Barrier / Preamp Interface	1	2007-12-31
1281-3010	Schematic, 1281 IS Barrier/Preamp Interface	1	2006-11-15
1281-2030	Layers Drawing, IS,Low Power AE Preamp (8 pages)	0	2007-12-31
1281-2031	Drill/Fabrication Drawing, I.S. Low Power AE Preamp (2 pages)	0A	2008-05-01
1281-2034	Assembly, I.S. Low Power AE Preamp	0	2006-07-17
1281-3030	Schematic, I.S. Low Power AE Preamp	0	2007-12-31
1281-5011	Label, Front Panel, IS Barrier / Preamp Interface	4	2013-11-14
1281-5015	Assembly, IS Barrier / Preamp Interface	1	2013-07-01
1281-5115	Assembly, IS Low Power Barrier / Preamp Interface	0	2013-07-03
1281-6000	1281 System Connections	5	2014-04-24
ISPK3I-5015	Assembly, ISPK3I Sensor	3	2014-04-24
ISPK3I-6DB-5015	Assembly, ISPXXI 6 dB Sensor	0	2014-04-24
ISPK3IUC-5015	Assembly, ISPK3IUC	4	2014-04-24
ISPKXXI-6DB-5015	Assembly, ISPKXXI 6 dB Sensor	0	2014-04-24
ISPKXXI-5015	Assembly, ISPKxxI Sensor	3	2014-04-24
ISPKXXIUC-5015	Assembly, ISPKxxIUC	4	2014-04-24
ISPK31UC-6DB-5015	Assembly, ISPK31UC-6dB	0	2014-04-24
ISPKXXIUC-6DB-5015	Assembly, ISPKxxIUC	0	2014-04-24
1281-5025	Ship Kit, ISPKxxI to Barrier	1	2013-07-01
1281-5035	Ship Kit ISPKxxIUC to Barrier	1	2013-07-01
1110-2080	Sensor, diode protection board (5 pages)	0	2002-10-10
1110-2081-IS	Drill drawing IS sensor diode protection board (2 pages)	0	2002-10-10
1110-2084-IS	Top assembly drawing, IS sensor diode protection board	0	2002-10-10
1110-3080-IS	Schematic, IS sensor diode protection board	0	2002-10-08
1281-5021	Label, top side ISPK preamplifier	3	2014-04-24
1281-5045	Ship Kit ISRXXCA-HT/ISPK-XX-S to barrier	2	2013-07-01
1281-5085-XXS-IS	Assy, ISPK-XXS single ended preamplifier	2	2013-07-01
1281-5095-XXS-IS	Assy, ISPK-XXS 6 dB single ended preamplifier	0	2013-07-01
ISR3CA-5015	Assembly ISR3CA-HT	3	2014-04-24
ISXXXCA-5015	Assembly ISR6CA-HT, ISR15CA-HT, ISR30CA-HT, ISR50CA-HT, ISWDCA-HT, ISF15CA-HT, ISF30CA-HT, & ISF50CA-HT	3	2014-04-24
1281-5013	Label Front Panel I.S. LP Barrier/Preamp Interface	0	2013-11-14
1281-5023	Label Top Side ISPK 6 dB Preamplifier	0	2014-04-24
1281-2040	Layers Drawing, 1281-LP IS Barrier Preamp Interface	0	2013-06-27
1281-2041	Drill Fabrication Drawing, 1281-LP IS Barrier/Preamp Interface	0	2013-06-27
1281-2044	Assembly Drawing, 1281-LP IS Barrier/Preamp Interface	0	2013-07-02
1281-3040	IS Low Power Barrier & Preamp Interface Schematic	0	2013-07-02
1281-2050	IS Low Power Preamp Solder Mask Artwork	0	2013-12-02
1281-2051	Drill/Fabrication Drawing IS Low Power AE Preamp	0	2013-07-02
1281-2054	Assembly Drawing IS Low Power AE Preamp	0	2013-07-02
1281-3050	IS Low Power 6 dB AE Preamp Schematic	0	2013-06-28

IECEx TEST REPORT
IEC 60079-11 and IEC 60079-0
Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"
Explosive atmospheres – Part 0: Equipment – General requirements

ExTR Reference Number..... :	NO/DNV/ExTR09.0003/04
ExTR Free Reference Number ..... :	PRJC-489530-2013-PRC-USA
Compiled by + signature (ExTL) .... :	Al Engler
Reviewed by + signature (ExTL).... :	Bjørn Spongsveen
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Ex Testing Laboratory (ExTL)..... :	Det Norsk Veritas Certification AS,
Address..... :	Veritasveien 1, 1322 Høvik, Norway
Applicant's name..... :	Mistras Group Inc.
Address..... :	195 Clarksville Rd. PRINCETON JCT., NJ, 08550-5303 USA
Standards..... :	IEC 60079-0:2011, 6th Edition, IEC 60079-11:2011 6th Edition
Test procedure..... :	IECEx System
Test Report Form Number..... :	ExTR60079-11_6A-2 (released 2012-06)

Instructions for Intended Use of Ex Test Report:
An Ex Test Report provides a clause-by-clause documentation of the initial evaluation and testing that verified compliance of an item or product with an IEC Ex standard. This Ex Test Report is part of an ExTR package that may include other Ex Test Report, Addendum, National Differences and Partial Testing documents, along with a single ExTR Cover. An Ex Test Report is to be compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the Ex Test Report as part of the overall ExTR package on the associated ExTR Cover.

Possible test case verdicts:

- test case does not apply to the test item .....:N / A
- test item does meet the requirement.....:Pass

General remarks:
The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

1 Any additions to scope on page 1

Temperature range specified is -55°C to +70°C and up to 150°C for some of the sensors.

2 Any additional details to equipment on page 2

See description on cover sheet.

3 Test and assessment
3.1 General aspects
3.1.1 Description of enclosure
3.1.1.a Metallic enclosures – light metal requirements

Equipment is rated for Ga and Da.
The sensor housings are both aluminium and non-metallic, an X condition is applied to aluminium enclosure to be installed to protect against ignition hazard due to impact.

3.1.1.b Non-metallic enclosure requirements

Equipment is rated for Ga and Da.
The barrier interface assembly is associated apparatus and this requirement does not apply. The non-metallic sensor enclosures have a surface resistance in excess of 1 Gohm, X condition applied to installation.

3.1.2 Thermal endurance requirements (only where enclosures require specific IP rating)

N/A –Specific IP rating is not required.

3.1.3 Resistance to chemical agents (only Group I non-metallic enclosures using Annex F)

N/A - Equipment is not Group I and annex F is not applied.

3.1.4 Impact test / assessment (only where enclosures require specific IP rating)

N/A

3.1.5 Drop test / assessment

N/A, not portable equipment.

3.1.6 Thermal Shock Test

N/A, no glass windows.

3.1.7 Ingress protection method and test (including gasket retention)

The 1281 barrier interface has a degree of protection of IP20 on the connection terminals. The pre-amp has a protection level of IP66 and have cable entries installed. The sensors are completely encapsulated with a fixed cable. The degree of protection is considered to be at least IP20. Sensor ISPKxxIUC has been tested to IP67. For details see test section.

3.1.8 Resistance to light test / assessment (only for non-metallic enclosures using Annex F)

N/A, Annex F not applied.

3.1.9 Connection arrangement, including entry provisions and transient protection requirements

All connections between the barrier interface and sensors are made by the use of BNC or SMA plugs. These plugs only carry one IS circuit and creepage and clearance is not relevant..

3.1.10 Dielectric strength test

The sensors have been tested with 500V. See test section.

3.1.11 Earthing, bonding and circulating currents

The Barrier Interface is earthed through a copper block mounted on the PCB. A screw is threaded into the block to allow for connection of a cable lug.

3.1.12 Encapsulation, including sealing test

All IS circuits are encapsulated in an epoxy resin. In the Barrier interface the component side is encapsulated, except for a trim potentiometer and the fuse. The sensors are completely encapsulated except for the connection plugs. The casting compound is tested with the force test of 30N with satisfactory result (see annex B). No parts of the casting compound are exposed, and the impact test is not performed.

3.1.13 Electrostatic hazard assessment and tests

Non-metallic enclosures have surface resistance in excess of 1 Gohm, X condtion applied and special condition for installation to avoid charging applied.

3.1.14 Printed circuit board, conformal coating, and coating to Annex F requirements

N/A, Annex F not applied

3.1.15 Partitions, including earth screens

N/A, no such partitions.

3.1.16 Cable pull test

The sensors have a permanently connected cable. However, the sensors do only have one intrinsically safe circuit and disconnection will not impair the safety.

3.1.17 Internal connectors

No internal connectors applied. All internal connections made by soldering.

3.1.18 Internal wiring

N/A, no internal wiring.

3.1.19 Marking requirements, including warning markings

Barrier interface have marking on the side of the enclosure by an adhesive label. The sensors are marked by engraving on top.

The following marking applies:

Manufacturers name and address.
Type
Ex-code
Serial number.
Certificate reference.

3.1.20 Instructions, including live maintenance procedures (if any)

The instruction manual covers the marking requirements and necessary information for putting into service and maintenance.

3.1.21 Any other general aspects

None

3.2 Spark ignition assessment and tests

Design of equipment to comply with spark ignition requirements The barrier interface is an associated apparatus. The output of the barrier protects the signal by the way of a fuse (62mA) three parallel paths of zener diodes (5,6V) and a current limiting resistor (20Ω). These components limit the energy available to the potential explosive atmosphere**.**

3.2.1 Apparatus supply and input/output parameters

Um = 250V
Uo = 5,6V + 5% = 5,88V
Io = 5,88V / (20Ω - 1%) = 0,297A
Po = (5,88V * 0,297A) / 4 = 0,44W
Lo = 0,35mH
Co = 43□F

3.2.2 Protection against polarity reversal

No batteries used – N/A

3.2.3 Resistive spark ignition assessment and tests

The maximum output voltage is limited by the three zener diodes on the output. This leads to a maximum voltage of 5,88V. The output current is limited by a current limiting resistor of 20Ω. This leads to an outpt current of 0,297A. At 5,88V the maximum allowed current according to table A.1 of IEC60079-11: 2006 is > 3,33 A.

3.2.4 Capacitive spark ignition assessment and tests

The maximum output voltage is 5,88V. According to table A.2 of IEC60079-11:2011 the maximum allowed capacitance at 5,9V including a safety factor of 1,5 is 43µF for gas group IIC. The total capacitance in the pre-amp and sensors are 36,38 µF including tolerances.

3.2.5 Inductive spark ignition assessment and tests

The maximum output current is 0,297A. According to figure A.6 of IEC60079-11:2006 the maximum allowed inductance at this current including a safety factor of 1,5 (=0,4455A) is 0,35mH for voltages below 8V.
The preamplifier which may be integrated into the sensors have an inductance of 4,7 mH. This inductance is protected by a resistor (R22) of 75Ω, 1%, 0,5W. The maximum current in the inductor will be 63,05 mA without taking into consideration any resistance in the inductor itself. The maximum energy including a safety factor of 1,5 is 21μJ which is well below the requirement of 40μJ for gas group IIC.

3.2.6 Combination of resistive, capacitive and inductive assessment and tests

The values for resistive, capacitive and inductive limits are listed separately – N/A.

3.2.7 Let-through energy assessment and tests

Active current limiters are not used – N/A

3.2.8 Semiconductor limiting power supply circuit tests

Active current limiters are not used – N/A

3.2.9 Any other spark ignition assessments and tests

The sensor contains a piezo electric device. In the new version with the pre-amplifier removed, two diodes are used to clamp any transient voltages due to impacts on the piezo electric device. An impact test has been performed to verify the effectiveness of the protective device. The capacitance of the piezo electric device has been measured to 0,56nF. The maximum voltage measured under the impact test was 10V. The energy is then calculated to:

E=1/2*C*V2 = ½*0,56nF*100 = 0,28μJ.

Test details are in the test section.

3.3 Thermal ignition assessment and tests

3.3.1 Design of equipment to comply with thermal ignition requirements

3.3.2 Components temperature assessment and tests, including small component ignition test

The pre-amplifier assembly is supplied from the barrier assembly. It is supplied with a maximum voltage of 5.6 V and the current is limited by a 62 mA fuse and a 20 Ohm, 2 W resistor. Additionally, there is a 75 Ohm 0.5 W resistor that limits the current further to a level of 62.5 mA when the tolerances are applied to the zener diodes and the resistors. This results in a maximum power of 0.3675 watts available to the pre-amp components. The maximum power transfer would be if the component had a resistance matching the resistance of 75 Ohms in the pre-amp, this would result in a power of 0.229 watts. U2 is the worst case component having a Θ_{JA} of 135°C/W. This would result in a temperature of 30.9°C at 0.229 watts at 25°C. This would result in a temperature of 75.9°C at an ambient temperature of 70°C. This would result in a temperature rating of T6. The pre-amplifier section is also encapsulated, so the temperature at the surface of the encapsulation would be lower than this value.

The sensors are completely encapsulated. On the models where the pre-amplifier is not integrated into the sensor assembly, there is a diode protection board installed which contains two protection diodes. The maximum measured surface temperature rise on the sensor at an applied power of 0,44W is 9,9K. Test results are in Section B.4. This would yield a temperature of 79.9°C at 70°C, and a temperature rating of T6.

3.3.3 Wiring temperature assessment and tests

No internal wiring in the sensors or the pre-amp. The barrier interface is an associated apparatus and this requirement does not apply – N/A.

3.3.4 Printed board tracks assessment and tests

The maximum supplied current to the pre-amp is 106 mA (1.7 X the fuse value of 62.5 mA). This meets the requirements for T6 from Table 3 de-rated for the maximum ambient temperature. The pre-amp and sensors are also encapsulated. The barrier interface is an associated apparatus and this requirement does not apply – N/A.

3.3.5 Enclosure external temperature assessments and tests

The barrier interface is an associated apparatus and this requirement does not apply. The sensors are completely encapsulated and are considered as one unit. The maximum supplied power to the sensors and the pre-amplifier if housed separately are 0,44W, this is acceptable for a temperature classification of T6 at 70°C for the pre-amplifier and sensors. For ambient temperatures up to 120°C the temperature class of the sensors can be T4. For ambient temperatures up to 150°C the temperature class can be T3.

The temperatures for the dust certification are based on the temperature class results for the temperatures found for the flammable gas evaluations.

3.3.6 Service temperature determination and assessment

The barrier interface is an associated apparatus and not located in the hazardous location, so this requirement does not apply – N/A.

3.3.7 Any other thermal ignition assessments and tests

None

3.4 Segregation requirements

The maxmum input voltage is 250V. The minimum critical distance under casting compound is 2 mm.

3.5 Safety components

3.5.1 Transformers

No transformers used as safety components – N/A.

3.5.2 Resistors

A film resistor is used as a current limiting resistor and considered as a safety component. The resistor is rated according to clause 7.1 of this standard.

3.5.3 Capacitors

Capacitors are not used as safety components – N/A.

3.5.4 Semiconductors

Zener diodes are used as shunt safety components to limit the voltage on the output of the barrier interface.

3.5.5 Opto-isolators

No opto-isolators used as safety components – N/A.

3.5.5.a Thermal conditioning, dielectric and carbonization test

3.5.5.a.1 Maximum temperature on receiver side after overload test

No opto-isolators used as safety components – N/A

3.5.5.a.2 Maximum temperature on transmitter side after overload test

No opto-isolators used as safety components – N/A

3.5.5.a.3 Thermal conditioning at maximum temperature of above + 10K

No opto-isolators used as safety components – N/A

3.5.5.a.4 Dielectric test at 3 kV

No opto-isolators used as safety components – N/A

3.5.5.a.5 Carbonisation test on receiver side after overload, thermal conditioning and dielectric test

No opto-isolators used as safety components – N/A

3.5.5.a.6 Carbonisation test on transmitter side after overload, thermal conditioning and dielectric test

No opto-isolators used as safety components – N/A

3.5.5.b Dielectric test, short circuit current test, and then dielectric test

3.5.5.b.1 Dielectric pre-test at 4 kV

No opto-isolators used as safety components – N/A

3.5.5.b.2 Current limited or short circuit current test

No opto-isolators used as safety components – N/A

3.5.5.b.3 Dielectric test after current test

No opto-isolators used as safety components – N/A

3.5.6 Relays

No relays used as safety components – N/A.

3.5.7 Fuses

A fuse is used to protect the zener diodes and current limiting resistor on the output. A value of 1,7 times the nominal fuse rating is used in calculations. The cold resistance of the fuse is not used in the assessment.

3.5.8 Infallible connections

All PCB tracks from the fuse F1 protecting the diodes D1-D3 through to the output of the barrier interface have a track width of 2mm, and a minimum thickness of 36,58□m. The maximum current available in these tracks is limited by the fuse F1 of 62mA The tracks are considered to withstand this without test. The infallible tracks are on both sides of the board. These tracks are connected with a single via. The circumference is 3mm and the plating thickness 25,4 □m. The thickness is less than specified in clause 8.7 (3). However the total area in the via is larger than specified in the standard, and due to a current of only 62ma*1,7 = 105,4 mA this is considered sufficient without a test. These are considered as infallible tracks.

3.5.9 Infallible windings

No damping windings applied – N/A.

3.5.10 Any other safety components used

None

3.5.11 Ratings of safety components

Component designation	Value	Rating used * (W2)	Maximum rating (W1)	W1 / W2	Calculation
Schematic 1281-3030					
R22	75Ω, 1%, 0,5W	0,29W	0,5W	1,72	I_{R20} = 5,88V / R20+R22 I_{R20} = 5,88V / ((75Ω*0,99)+(20Ω*.99))=62,52 mA. P_{R20} = $(0,06252A)^2$ * 75Ω*0,99 = **0,29W**
Schematic 1281-3010					
D1, D2, D3	5,6V, 10%, 1,5W	0,62W	1,5W	2,42	P_{D1-D3}= I_{fuse}*1,7*U_z P_{D1-D3}= 0,062A*1,7*5,88V P_{D1-D3}= **0,62W**
R20	20Ω, 1%, 2W	0,22W	2W	9,09	P_{R20}= $(I_{fuse}*1,7)^2$ * R_{R20} P_{R20}= $(0,062A*1,7)^2$ * 20Ω*1,01 = 0,22W

(* "Rating used" is a term used to describe the maximum voltage, current and/or power which the component may be subjected to when applying the number of faults as prescribed in the Standards)

3.6 Requirements of specific components and apparatus

3.6.1 Batteries

No batteries used - N/A.

3.6.1.a Determination of charge capacity on discharge at normal load

No batteries used - N/A.

3.6.1.b Electrolyte leakage during charge with one cell fully discharged or with polarity reversal.

No batteries used - N/A.

3.6.1.c Electrolyte leakage during discharge into short circuit

No batteries used - N/A.

3.6.1.d Determination of equivalent internal resistance

No batteries used - N/A.

3.6.1.e Spark ignition assessment or test

No batteries used - N/A.

3.6.1.f Surface temperature test when short circuited

No batteries used - N/A.

3.6.1.g Battery container ventilation and pressure test

No batteries used – N/A.

3.6.1 Piezo electric devices

The sensor contains a piezo electric device. In the new version with the pre-amplifier removed, two diodes are used to clamp any transient voltages due to impacts on the piezo electric device. An impact test has been performed to verify the effectiveness of the protective device. The capacitance of the piezo electric device has been measured to 0,56nF. The maximum voltage measured under the impact test was 10V. The energy is then calculated to:

E=1/2*C*V2 = ½*0,56nF*100 = 0,28µJ.

Test details are in the test section.

3.6.2 Electromagnetic, laser and ultrasonic energy

No RF, laser or ultrasonic devices.

3.6.3 Safety barriers – assessments and tests

The 1281 barrier interface unit is considered as an interface with a safe output. The component side of the board is completely encapsulated.

3.6.4 FISCO apparatus

3.6.4.1 FISCO Power Supplies

Not FISCO equipment.

3.6.4.2 FISCO Field Devices

Not FISCO equipment.

3.6.4.3 FISCO Terminator

Not FISCO equipment.

3.6.4.4 FISCO Simple Apparatus

Not FISCO equipment.

3.6.4.5 FISCO Marking

Not FISCO equipment.

3.6.5 Handlights and caplights

Not handlights or caplights

3.6.6 Simple apparatus

No simple apparatus

3.6.7 Accessories used for intrinsically safe apparatus

No accessories such as chargers or other equipment.

3.6.8 Determination of parameters of loosely specified components

None.

3.6.9 Ex components and their mounting method

Not an Ex component.

3.6.10 Any other components

None.

4 Results

The 1281 barrier interface, sensors and separate pre-amplifiers listed comply with the requirements of IEC 60079-0:2011 and IEC 60079-11:2011.

5 Additional information

None.

SECTION A COMPLIANCE CHECK LISTS

Section A.1

IEC 60079-0:2011 Edition 6 Explosive atmospheres - Part 0: Equipment – General requirements			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
1	Scope	Page 1, 1	Pass
2	Normative references	No requirement	
3	Terms and definitions	No requirement	
4	Equipment grouping		
4.1	Group I	Page 1, 1, 3.1.19, 3.2	N/A
4.2	Group II	Page 1, 1, 3.2	Pass
4.3	Group III	Page 1, 1, 3.2	Pass
4.4	Equipment for a particular explosive atmosphere	Page 1, 1, 3.1.19	N/A
5	Temperatures		
5.1	Environmental influences		
5.1.1	Ambient temperature	Page 1, 1, 3.1.19, 3.3	Pass
5.1.2	External source of heating or cooling	Page 1, 1, 3.3.1, Page 2	N/A
5.2	Service temperature	3.3.6	Pass
5.3	Maximum surface temperature		
5.3.1	Determination of maximum surface temperature	3.3	Pass
5.3.2	Limitation of maximum surface temperature		
5.3.2.1	Group I electrical equipment	Page 1, 1, 3.3	N/A
5.3.2.2	Group II electrical equipment	Page 1, 1, 3.3	Pass
5.3.2.3	Group III electrical equipment		
5.3.2.3.1	Maximum surface temperature determined without a dust layer	Page 1, 1, 3.3	Pass
5.3.2.3.2	Maximum surface temperature with respect to dust layers	Page 1, 1, 3.3	N/A
5.3.3	Small component temperature for Group I or Group II electrical equipment	Page 1, 1, 3.3	N/A
5.3.3	Small component temperature for Group I or Group II electrical equipment	Page 1, 1, 3.3	N/A
6	Requirements for all electrical equipment		
6.1	General	Page 1, 1, 3, 4	Pass
6.2	Mechanical strength of equipment	3.1.4, 3.1.5, 3.1.6	N/A
6.3	Opening times	Excluded	N/A
6.4	Circulating currents in enclosures (e.g. of large electrical machines)	Excluded	N/A
6.5	Gasket retention	3.1.7	N/A
6.6	Electromagnetic and ultrasonic energy radiating equipment	3.6.3	N/A
6.6.1	Radio frequency sources	3.6.3	N/A
6.6.2	Laser or other continuous wave sources	3.6.3	N/A
6.6.3	Ultrasonic sources	3.6.3	N/A
7	Non-Metallic enclosures and non-metallic parts of enclosures		
7.1	General		
7.1.1	Applicability	Excluded	
7.1.2	Specification of materials		

IEC 60079-0:2011 Edition 6 Explosive atmospheres - Part 0: Equipment – General requirements			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
7.1.2.1	General	Excluded	
7.1.2.2	Plastic materials	Excluded	
7.1.2.3	Elastomers	Excluded	
7.2	Thermal endurance		
7.2.1	Tests for thermal endurance	Excluded	
7.2.2	Material selection	Excluded	
7.2.3	Alternative qualification of elastomeric sealing O-rings	Excluded	
7.3	Resistance to light	Excluded	
7.4	Electrostatic charges on external non-metallic materials		
7.4.1	Applicability	3.1.13	
7.4.2	Avoidance of a build-up of electrostatic charge on Group I or Group II electrical equipment	3.1.13, 3.1.19, Page 2	Pass
7.4.3	Avoidance of a build-up of electrostatic charge on equipment for Group III	3.1.13, 3.1.19, Page 2	Pass
7.5	Accessible metal parts	Excluded	
8	Metallic enclosures and metallic parts of enclosures		
8.1	Material composition	3.1.1.a	Pass
8.2	Group I	3.1.1.a	N/A
8.3	Group II	3.1.1.a	Pass
8.4	Group III	3.1.1.a	Pass
9	Fasteners		
9.1	General	Excluded	
9.2	Special fasteners	Excluded	
9.3	Holes for special fasteners		
9.3.1	Thread engagement	Excluded	
9.3.2	Tolerance and clearance	Excluded	
9.3.3	Hexagon socket set screws	Excluded	
10	Interlocking devices	Excluded	
11	Bushings	Excluded	
12	Materials used for cementing	Excluded	
13	Ex components		
13.1	General	3.6.10	N/A
13.2	Mounting	3.6.10	N/A
13.3	Internal mounting	3.6.10	N/A
13.4	External mounting	3.6.10	N/A
13.5	Ex Component certificate	3.6.10	N/A
14	Connection facilities and terminal compartments		

IEC 60079-0:2011 Edition 6 **Explosive atmospheres - Part 0: Equipment – General requirements**			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
14.1	General	Excluded	
14.2	Termination compartment	Excluded	
14.3	Type of protection	Excluded	
14.4	Creepage and clearance	Excluded	
15	Connection facilities for earthing or bonding conductors		
15.1	Equipment requiring earthing		
15.1.1	Internal	Excluded	
15.1.2	External	Excluded	
15.2	Equipment not requiring earthing	Excluded	
15.3	Size of conductor connection	Excluded	
15.4	Protection against corrosion	Excluded	
15.5	Secureness of electrical connections	Excluded	
16	Entries into enclosures		
16.1	General	Excluded	
16.2	Identification of entries	Excluded	
16.3	Cable glands	Excluded	
16.4	Blanking elements	Excluded	
16.5	Thread adapters	Excluded	
16.6	Temperature at branching point and entry point	Excluded	
16.7	Electrostatic charges of cable sheaths	Excluded	
17	Supplementary requirements for rotating machines		
17.1	Ventilation		
17.1.1	Ventilation openings	Excluded	
17.1.2	Materials for external fans	Excluded	
17.1.3	Cooling fans of rotating machines		
17.1.3.1	Fans and fan hoods	Excluded	
17.1.3.2	Construction and mounting of the ventilating systems	Excluded	
17.1.3.3	Clearances for the ventilating system	Excluded	
17.1.4	Auxiliary motor cooling fans	Excluded	
17.1.5	Ventilating fans		
17.1.5.1	Applicability	Excluded	
17.1.5.2	General	Excluded	
17.1.5.3	Fan and fan hoods	Excluded	
17.1.5.4	Construction and mounting	Excluded	
17.1.5.5	Clearances for rotating parts	Excluded	
17.2	Bearings	Excluded	
18	Supplementary requirements for switchgear		
18.1	Flammable dielectric	Excluded	
18.2	Disconnectors	Excluded	
18.3	Group I – Provisions for locking	Excluded	
18.4	Doors and covers	Excluded	
19	Supplementary requirements for fuses	Excluded	
20	Supplementary requirements for plugs, socket outlets and connectors		

IEC 60079-0:2011 Edition 6 Explosive atmospheres - Part 0: Equipment – General requirements			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
20.1	General	Excluded	
20.2	Explosive gas atmospheres	Excluded	
20.3	Explosive dust atmospheres	Excluded	
20.4	Energized plugs	Excluded	
21	Supplementary requirements for luminaires		
21.1	General	Excluded	
21.2	Covers for luminaires of EPL Mb, EPL Gb or EPL Db	Excluded	
21.3	Covers for luminaires of EPL Gc or EPL Dc	Excluded	
21.4	Sodium lamps	Excluded	
22	Supplementary requirements for caplights and handlights		
22.1	Group I Caplights	3.6.6	N/A
22.2	Group II and Group III Caplights and handlights	3.6.6	N/A
23	Equipment incorporating cells and batteries		
23.1	General	3.6.1	N/A
23.2	Batteries	3.6.1	N/A
23.3	Cell types	3.6.1	N/A
23.4	Cells in a battery	3.6.1	N/A
23.5	Ratings of batteries	3.6.1	N/A
23.6	Interchangeability	3.6.1	N/A
23.7	Charging of primary batteries	3.6.1	N/A
23.8	Leakage	3.6.1	N/A
23.9	Connections	3.6.1	N/A
23.10	Orientation	3.6.1	N/A
23.11	Replacement of cells or batteries	3.6.1, 3.1.19, Page 2	N/A
23.12	Replaceable battery pack	3.6.1, 3.1.19, Page 2	N/A
24	Documentation	Page 3	Pass
25	Compliance of prototype or sample with documents	2, 3, Page 3	Pass
26	Type tests		
26.1	General	2, 3, 7, Page 3	Pass
26.2	Test configuration	3	Pass
26.3	Tests in explosive test mixtures	3	N/A
26.4	Tests of enclosures		
26.4.1	Order of tests	Excluded	
26.4.1.1	Metallic enclosures, metallic parts of enclosures and glass parts of enclosures	Excluded	
26.4.1.2	Non-metallic enclosures or non-metallic parts of enclosures	Excluded	
26.4.1.2.1	Group I electrical equipment	Excluded	
26.4.1.2.2	Group II and Group III electrical equipment	Excluded	
26.4.2	Resistance to impact	Excluded	
26.4.3	Drop test	3.1.5	N/A
26.4.4	Acceptance criteria	3.1.4, 3.1.5	N/A
26.4.5	Degree of protection (IP) by enclosures		

IEC 60079-0:2011 Edition 6 Explosive atmospheres - Part 0: Equipment – General requirements			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
26.4.5.1	Test procedure	3.1.7	Pass
26.4.5.2	Acceptance criteria	3.1.7	Pass
26.5	Thermal tests		
26.5.1	Temperature measurement		
26.5.1.1	General	3.3.1, 3.3.6	Pass
26.5.1.2	Service Temperature	3.3.6	Pass
26.5.1.3	Maximum Surface Temperature	3.3	Pass
26.5.2	Thermal shock test	3.1.6	N/A
26.5.3	Small component ignition test (Group I and Group II)		
26.5.3.1	General	3.3.2	N/A
26.5.3.2	Procedure	3.3.2	N/A
26.5.3.3	Acceptance criteria	3.3.2	N/A
26.6	Torque test for bushings		N/A
26.6.1	Test procedure	Excluded	
26.6.2	Acceptance criteria	Excluded	
26.7	Non-metallic enclosures or non-metallic parts of enclosures		
26.7.1	General	3.1.1.b, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8	
26.7.2	Test temperatures	Excluded	
26.8	Thermal endurance to heat	Excluded	
26.9	Thermal endurance to cold	Excluded	
26.10	Resistance to light		
26.10.1	Test procedure	Excluded	
26.10.2	Acceptance criteria	Excluded	
26.11	Resistance to chemical agents for Group I electrical equipment	Excluded	
26.12	Earth continuity	Excluded	
26.13	Surface resistance test of parts of enclosures of non-metallic materials	3.1.13	Pass
26.14	Measurement of capacitance		
26.14.1	General	3.1.13	N/A
26.14.2	Test procedure	3.1.13	N/A
26.15	Verification of ratings of ventilation fans	Excluded	
26.16	Alternative qualification of elastomeric sealing O-rings	Excluded	
27	Routine tests	Page 2	N/A
28	Manufacturer's responsibility		
28.1	Conformity with the documentation	No requirement	Pass
28.2	Certificate	No requirement	Pass
28.3	Responsibility for marking	No requirement	Pass
29	Marking		

IEC 60079-0:2011 Edition 6 Explosive atmospheres - Part 0: Equipment – General requirements			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
29.1	Applicability	3.1.19	Pass
29.2	Location	3.1.19	Pass
29.3	General	3.1.19	Pass
29.4	Ex marking for explosive gas atmospheres	3.1.19	Pass
29.5	Ex marking for explosive dust atmospheres	3.1.19	Pass
29.6	Combined types (or levels) of protection	3.1.19	N/A
29.7	Multiple types of protection	3.1.19	N/A
29.8	Ga equipment using two independent Gb types (or levels) of protection	3.1.19	N/A
29.9	Ex Components	3.1.19	N/A
29.10	Small equipment and small Ex components	3.1.19	Pass
29.11	Extremely small equipment and extremely small Ex components	3.1.19	N/A
29.12	Warning markings	3.1.19	N/A
29.13	Alternative marking of equipment protection levels (EPLs)	3.1.19	N/A
29.13.1	Alternative marking of type of protection for explosive gas atmospheres	3.1.19	N/A
29.13.2	Alternative marking of type of protection for explosive dust atmospheres	3.1.19	N/A
29.14	Cells and batteries	3.1.19	N/A
29.15	Converter-fed electrical machines	Excluded	
29.16	Examples of marking	3.1.19	N/A
30	Instructions		
30.1	General	3.1.20	Pass
30.2	Cells and batteries	3.1.20	N/A
30.3	Electrical machines	Excluded	
30.4	Ventilating fans	Excluded	
Annex A (normative)	Supplementary requirement for cable glands	Excluded	
Annex B (normative)	Requirements for Ex components	3.6.10	N/A
Annex C (informative)	Example of rig for resistance to impact test	3.1.4	N/A
Annex D (informative)	Motors supplied by converters	Excluded	N/A
Annex E (informative)	Temperature rise testing of electric machines	Excluded	N/A
Annex F (informative)	Guideline flowchart for tests of non-metallic enclosures or non-metallic parts of enclosures (26.4)	3.1	N/A

Section A.2

IEC 60079-11:2011 Edition 6 **Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"**			
No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
1	Scope	Page 1, 1	Pass
2	Normative references	No requirement	
3	Terms and definitions	No requirement	
4	Grouping and classification of intrinsically safe apparatus and associated apparatus	Page 1, 1	Pass
5	Levels of protection and ignition compliance requirements of electrical apparatus		
5.1	General	Page 1, 1, 3.1.19, 3.1.20, 3.2.1, 3.2.2, 3.3.1, 3.4, Page 2	Pass
5.2	Level of protection "ia"	Page 1, 1, 3.1.19, 3.2, 3.3, 3.4	Pass
5.3	Level of protection "ib"	Page 1, 1, 3.1.19, 3.2, 3.3, 3.4	N/A
5.4	Level of protection "ic"	Page 1, 1, 3.1.19, 3.2, 3.3, 3.4	N/A
5.5	Spark ignition compliance	3.2	Pass
5.6	Thermal ignition compliance		
5.6.1	General	3.3	Pass
5.6.2	Temperature for small components for Group I and Group II	3.3.2	Pass
5.6.3	Wiring within intrinsically safe apparatus for Group I and Group II	3.3.3	Pass
5.6.4	Tracks on printed circuit boards for Group I and Group II	3.3.4	Pass
5.6.5	Intrinsically safe apparatus and component temperature for Group III	3.1.1, 3.1.7, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6	Pass
5.7	Simple apparatus	3.6.7	N/A
6	Apparatus construction		
6.1	Enclosures		
6.1.1	General	3.1.1, 3.1.7	Pass
6.1.2	Enclosures for Group I or Group II apparatus		
6.1.2.1	General	3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.4	Pass
6.1.2.2	Apparatus complying with Table 5	3.1.1, 3.1.5, 3.1.7, 3.4	Pass
6.1.2.3	Apparatus complying with Annex F	3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.4	N/A
6.1.3	Enclosures for Group III apparatus	3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.3.1, 3.4	Pass
6.2	Facilities for connection of external circuits		
6.2.1	Terminals	3.1.9, 3.4	Pass
6.2.2	Plugs and sockets	3.1.9, 3.1.11, 3.4	N/A
6.2.3	Determination of maximum external inductance to resistance ratio (Lo/Ro) for resistance limited power source	3.2.2, 3.2.6	Pass
6.2.4	Permanently connected cable	3.1.9, 3.1.16	Pass
6.2.5	Requirements for connections and accessories for IS apparatus when located in the non-hazardous area	3.6.8	N/A

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No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
6.3	Separation distances		
6.3.1	General	3.4	Pass
6.3.2	Separation of conductive parts	3.1.14, 3.2.1, 3.3.1 3.4	Pass
6.3.2.1	Distances according to Table 5	3.4	Pass
6.3.2.2	Distances according to Annex F	3.4	N/A
6.3.3	Voltage between conductive parts	3.4	Pass
6.3.4	Clearance	3.1.14, 3.4	Pass
6.3.5	Separation distances through casting compound	3.1.10, 3.1.12, 3.4	Pass
6.3.6	Separation distances through solid insulation	3.1.10, 3.4	N/A
6.3.7	Composite separations	3.4	N/A
6.3.8	Creepage distance	3.1.14, 3.1.15, 3.4	Pass
6.3.9	Distance under coating	3.1.14, 3.4	Pass
6.3.10	Requirements for assembled printed circuit boards	3.1.14, 3.4	Pass
6.3.11	Separation by earthed screens	3.1.11, 3.1.15, 3.4	N/A
6.3.12	Internal wiring	3.1.10, 3.1.18, 3.4	N/A
6.3.13	Dielectric strength requirement	3.1.10	Pass
6.3.14	Relays	3.1.10, 3.1.15, 3.4, 3.5.6	N/A
6.4	Protection against polarity reversal	3.2.3	N/A
6.5	Earth conductors, connections and terminals	3.1.9, 3.1.11	Pass
6.6	Encapsulation		Pass
6.6.1	General	3.1.12	Pass
6.6.2	Encapsulation used for the exclusion of explosive atmospheres	3.1.12	Pass
7	Components on which intrinsic safety depends		
7.1	Rating of components	3.2.2, 3.5.11	Pass
7.2	Connectors for internal connections, plug-in cards and components	3.1.11, 3.1.17	N/A
7.3	Fuses	3.1.12, 3.2.2, 3.5.7, 3.5.11	N/A
7.4	Primary and secondary cells and batteries		
7.4.1	General	3.1.19, 3.1.20, 3.6.1, Page 2	N/A
7.4.2	Battery construction	3.6.1	N/A
7.4.3	Electrolyte leakage and ventilation	3.1.12, 3.6.1.b, 3.6.1.c	N/A
7.4.4	Cell voltages	3.2.1, 3.3.1, 3.6.1	N/A
7.4.5	Internal resistance of cell or battery	3.6.1.d	N/A
7.4.6	Batteries in equipment protected by other types of protection	3.2.1, 3.2.2, 3.5.11 3.6.1, Page 2	N/A
7.4.7	Batteries used and replaced in explosive gas atmospheres	3.1.5, 3.1.11, 3.6.1	N/A
7.4.8	Batteries used but not replaced in explosive gas atmospheres	3.1.5, 3.1.19, 3.1.20, 3.6.1	N/A
7.4.9	External contacts for charging batteries	3.1.9, 3.2.2, 3.6.1	N/A
7.5	Semiconductors		
7.5.1	Transient effects	3.5.4	Pass
7.5.2	Shunt voltage limiters	3.2.8, 3.2.9, 3.5.4, 3.5.11	Pass
7.5.3	Series current limiters	3.2.9, 3.5.4, 3.5.11	N/A
7.6	Failure of components, connections and separations	1, 3.1.18, 3.2.1, 3.2.4, 3.2.5, 3.2.6,	N/A

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No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
		3.3.2, 3.4, 3.5.11	
7.7	Piezo-electric devices	3.6.2	Pass
7.8	Electrochemical cells for the detection of gases	3.2.1, 3.2.4, 3.2.5	N/A
8	Infallible components, infallible assemblies of components and infallible connections on which intrinsic safety depends		
8.1	Level of Protection "ic"	Page 1, 1	N/A
8.2	Mains transformers		
8.2.1	General	3.5.1	N/A
8.2.2	Protective measures	3.5.1, 3.5.7, 3.5.11	N/A
8.2.3	Transformer construction	3.1.10, 3.4, 3.5.1, 3.5.7, 3.5.11	N/A
8.2.4	Transformer type tests	3.1.10, 3.4, 3.5.1, 3.5.11	N/A
8.2.5	Routine test of mains transformers	3.5.1, Page 2	N/A
8.3	Transformers other than mains transformers	3.5.1, 3.5.11, Page 2	N/A
8.4	Infallible windings		
8.4.1	Damping windings	3.5.9, 3.5.11	N/A
8.4.2	Inductors made by insulated conductors	3.5.9, 3.5.11	N/A
8.5	Current-limiting resistors	3.5.2, 3.5.11	N/A
8.6	Capacitors		
8.6.1	Blocking capacitors	3.1.10, 3.5.3, 3.5.11	N/A
8.6.2	Filter capacitors	3.4, 3.5.3, 3.5.11	N/A
8.7	Shunt safety assemblies		
8.7.1	General	3.2.8, 3.5.4, 3.5.7, 3.5.11	Pass
8.7.2	Safety shunts	3.5.4	Pass
8.7.3	Shunt voltage limiters	3.5.4	Pass
8.8	Wiring, printed circuit board tracks, and connections	3.1.14, 3.1.17, 3.5.8	Pass
8.9	Galvanically separating components		
8.9.1	General	3.5.5, 3.5.6	N/A
8.9.2	Isolating components between intrinsically safe and non-intrinsically safe circuits	3.1.10, 3.5.5, 3.5.6, 3.5.11	N/A
8.9.3	Isolating components between separate intrinsically safe circuits	3.1.10, 3.5.5, 3.5.6, 3.5.11	N/A
9	Supplementary requirements for specific apparatus		
9.1	Diode safety barriers		
9.1.1	General	3.5.4, 3.5.11, 3.6.4, Page 2	Pass
9.1.2	Construction		
9.1.2.1	Mounting	3.6.4	Pass
9.1.2.2	Facilities for connection to earth	3.1.11	Pass
9.1.2.3	Protection of components	3.1.12	Pass
9.2	FISCO apparatus	3.6.5	N/A
9.3	Handlights and caplights	3.6.6	N/A
10	Type verifications and type tests		
10.1	Spark ignition test		
10.1.1	General	3.2, 3.4	N/A
10.1.2	Spark test apparatus	3.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.9, 3.4, 3.5.8	N/A

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No:	**Heading of clause**	**Report section no., or 'Excluded' or 'No requirement'**	**Notes**
10.1.3	Test gas mixtures and spark test apparatus calibration current		
10.1.3.1	Explosive test mixtures suitable for tests with a safety factor of 1,0 and calibration current of the spark test apparatus	3.2	N/A
10.1.3.2	Explosive test mixtures suitable for tests with a safety factor of 1,5 and calibration current of the spark test apparatus	3.2	N/A
10.1.4	Tests with the spark test apparatus		
10.1.4.1	Circuit test	3.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.9, 3.4, 3.5.8	N/A
10.1.4.2	Safety factors	3.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.9, 3.4, 3.5.8	N/A
10.1.5	Testing considerations		
10.1.5.1	General	3.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.9, 3.4, 3.5.8	N/A
10.1.5.2	Circuits with both inductance and capacitance	3.2.2, 3.2.7, Page 2	N/A
10.1.5.3	Circuits using shunt short-circuit (crowbar) protection	3.2, 3.2.4, 3.2.8	N/A
10.1.5.4	Results of spark tests	3.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.9	N/A
10.2	Temperature tests	3.3, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.5.1	Pass
10.3	Dielectric strength tests	3.1.10, Page 2	Pass
10.4	Determination of parameters of loosely specified components	3.6.9	N/A
10.5	Tests for cells and batteries		
10.5.1	General	3.6.1, 3.6.1.a, 3.6.1.c	N/A
10.5.2	Electrolyte leakage test for cells and batteries	3.6.1.b, 3.6.1.c	N/A
10.5.3	Spark ignition and surface temperature of cells and batteries	3.6.1.d, 3.6.1.e, 3.6.1.fsection3_6_1	N/A
10.5.4	Battery container pressure tests	3.1.2, 3.1.5, 3.4, 3.6.1.g	N/A
10.6	Mechanical tests		
10.6.1	Casting compound	3.1.4, 3.1.12 section3_1_7	Pass
10.6.2	Determination of the acceptability of fuses requiring encapsulation	3.1.12, 3.5.7	N/A
10.6.3	Partitions	3.1.15	N/A
10.7	Tests for intrinsically safe apparatus containing piezoelectric devices	3.1.4, 3.6.2, Page 2	Pass
10.8	Type tests for diode safety barriers and safety shunts	3.5.4, 3.6.4	Pass
10.9	Cable pull test	3.1.16	N/A
10.10	Transformer tests	3.1.10, 3.5.1	N/A
10.11	Optical isolators tests		
10.11.1	General	3.5.5	N/A
10.11.2	Thermal conditioning, dielectric and carbonization test	3.5.5.a	N/A
10.11.2.1	Overload test at the receiver side	3.5.5.a.1	N/A
10.11.2.2	Overload test at the transmitter side	3.5.5.a.2	N/A
10.11.2.3	Thermal conditioning and dielectric strength test	3.1.10, 3.5.5.a.3, 3.5.5.a.4	N/A

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10.11.2.4	Carbonisation test		
10.11.2.4.1	Receiver side	3.5.5.a.5	N/A
10.11.2.4.2	Transmitter side	3.5.5.a.6	N/A
10.11.3	Dielectric and short-circuit test		
10.11.3.1	General	3.5.5.b	N/A
10.11.3.2	Pre-test dielectric	3.1.10, 3.5.5.b.1	N/A
10.11.3.3	Short-circuit current test	3.5.5.b.2	N/A
10.11.3.4	Current limited short-circuit current test	3.5.5.b.2	N/A
10.11.3.5	Dielectric strength test	3.1.10, 3.5.5.b.3	N/A
10.12	Current carrying capacity of infallible printed circuit board connections	3.3.4	N/A
11	Routine verifications and tests		
11.1	Routine tests for diode safety barriers		
11.1.1	Completed barriers	3.6.4, Page 2	N/A
11.1.2	Diodes for 2-diode "ia" barriers	3.6.4, Page 2	N/A
11.2	Routine tests for infallible transformers	3.1.10, 3.5.1, Page 2	N/A
12	Marking		
12.1	General	3.1.19	Pass
12.2	Marking of connection facilities	3.1.7, 3.1.9, 3.1.19	N/A
12.3	Warning markings	3.1.19, Page 2	N/A
12.4	Examples of marking	3.1.19	N/A
13	Documentation	3.1.19, 3.1.20, 3.2.2, Page 2, Page 3	Pass
Annex A (normative)	Assessment of intrinsically safe circuits		
A.1	Basic criteria	3.2, 3.3, 3.4	Pass
A.2	Assessment using reference curves and tables	3.2	Pass
A.3	Examples of simple circuits	No requirement	
A.4	Permitted reduction of effective capacitance when protected by a series resistance	3.2.5	N/A
Annex B (normative)	Spark test apparatus for intrinsically safe circuits		
B.1	Test methods for spark ignition		
B.1.1	Principle	3.2	N/A
B.1.2	Apparatus	3.2	N/A
B.1.3	Calibration of spark test apparatus	3.2	N/A
B.1.4	Preparation and cleaning of tungsten wires	3.2	N/A
B.1.5	Conditioning a new cadmium disc	3.2	N/A
B.1.6	Limitations of the apparatus	3.2	N/A
B.1.7	Modifications of test apparatus for use at higher currents	3.2	N/A
Annex C (informative)	Measurement of creepage distances, clearances and separation distances through casting compound and through solid insulation		
C.1	Clearances and separation distances through casting compound and through solid insulation	3.4	N/A
C.2	Creepage distances	3.4	N/A
Annex D (normative)	Encapsulation		
D.1	Adherence	3.1.12	N/A
D.2	Temperature	3.1.12section3_1_7	N/A
Annex E	Transient energy test		

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E.1	Principle	3.2.8	N/A
E.2	Test	3.2.8	N/A
Annex F (normative)	Alternative separation distances for assembled printed circuit boards and separation of components		
F.1	General	Page1, 1, 3.1.7, 3.1.14, 3.1.19, 3.1.20, 3.5.5, 3.5.6	N/A
F.2	Control of pollution access	3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.12, 3.1.14, 3.1.19, 3.1.20, 3.4, Page 2	N/A
F.3	Distances for printed circuit boards and separation of components		
F.3.1	Levels of protection "ia" and "ib"	3.1.7, 3.1.12, 3.1.14, 3.1.19, 3.1.20, 3.4, Page 2	N/A
F.3.2	Level of protection "ic"	3.1.7, 3.1.14, 3.1.19, 3.1.20, 3.4, Page 2	N/A
Annex G (normative)	Fieldbus intrinsically safe concept (FISCO) – Apparatus requirements		
G.1	Overview	3.6.5	N/A
G.2	Apparatus requirement		
G.2.1	General	3.6.5	N/A
G.2.2	FISCO power supplies		
G.2.2.1	General	3.6.5.1	N/A
G.2.2.2	Additional requirements of 'ia' and 'ib' FISCO power supplies	3.6.5.1	N/A
G.2.2.3	Additional requirements of 'ic' FISCO power supplies	3.6.5.1	N/A
G.3	FISCO field devices		
G.3.1	General	3.6.5.2	N/A
G.3.2	Additional requirements of 'ia' and 'ib' FISCO field devices	3.6.5.2	N/A
G.3.3	Additional requirements of 'ic' FISCO field devices	3.6.5.2	N/A
G.3.4	Terminator	3.6.5.3	N/A
G.3.5	Simple apparatus	3.6.5.4	N/A
G.4	Marking	3.1.19, 3.6.5.5	N/A
G.4.1	Examples of marking	3.6.5.5	N/A
Annex H (informative)	Ignition testing of semiconductor limiting power supply circuits		
H.1	Overview	3.2.9	N/A
H.2	Test	3.2.9	N/A

SECTION B: Tests

B.1 Mechanical tests – Casting compound (From ExTR09.0009/01)

Equipment Tested	Casting compound in preamplifier type IS-PK PREAMP
Date of Test	2008-01-16
Standards	IEC60079-11:2006 clause 10.6.1
Test equipment	#194, #432

B.1.1 Test Procedure

A force of 30 N was applied perpendicular to the exposed surface of casting compound using a 6 mm diameter flat ended metal rod for 10 s.

B.1.2 Results

No movement of the test rod was observed during the test. The test rod did not leave any marks on the surface of the casting compound.

B.2 Dielectric strength test (From ExTR09.0009/01)

Equipment Tested	Sensor ISPK6IUC S/N AA01
Date of Test	2008-01-16
Standards	IEC60079-11:2006 clause 10.3
Test equipment	#326

B.2.1 Test Procedure

An AC voltage of 500V was supplied between the input circuit and the enclosure covered with metal foil. Duration of test was 1 minute.

B.2.2 Results

No flashover. The leakage current was below 1mA.

B.3 IP test (IP67) (From ExTR09.0009/01)

Equipment Tested	Sensor type ISPKxxIUC
Date of Test	2009-03-12
Standards	IEC60079-11:2006 clause 6.1, IEC60529
Test equipment	#326, #976

B.3.1 Test Procedure

The sensor is completely encapsulated. The test for IP6X (dust) was waived due to the construction. Fully encapsulated without voids. The test for IPX7 was performed by placing the sensor in water at a depth of 1 meter for 30 minutes. Followed by a dielectric strength test between the circuit and copper tape placed on the sensor surface. During the dielectric strength test the sensor was still submersed in water.

B.3.2 Results

No flashover. The leakage current was below 1mA.

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B.4 Tests from ExTR09.0003/02 Addendum

A.1 Temperature measurement.

Equipment Tested	Sensor ISR15CA
Date of Test	2010-02-19
Standards	IEC/EN60079-0
Instruments used	#713, #1019

A.1.1 Test Procedure

A voltage of 5,88V and a current of 297mA was applied to the sensor. The temperature was measured on the surface.

A.1.2 Results

Maximum temperature rise was measured to 9,9K.

B.5 Impact tests on piezo electric device

A.2 Impact test on piezo electric device

Equipment Tested	Sensor ISR15CA
Date of Test	2009-12-15
Standards	IEC/EN60079-11, clause 10.7
Instruments used	#408

A.2.1 Test Procedure

The sensor was placed on the steel base of the impact test apparatus. The sensor was then connected to an oscilloscope. An impact of 7J was applied, and the signal recorded.

A.2.2 Results

Measured 10 V peak to peak